HYPERNATREMIA IN THE AGING: CAUSES, MANIFESTATIONS, AND OUTCOME

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The incidence, clinical manifestations, morbidity, and mortality of all adult hypernatremic patients hospitalized during a 6-month period were studied. The impact of age on this parameter was evaluated, and the velocity of correction that produced best clinical results was established. Records of all patients who were admitted or developed hypernatremia (Na+ >150 mEq/L) were reviewed. Demographic characteristics of age, gender, associated diagnosis, length of stay, source of admission, treatment, and outcome were recorded. Of 3209 hospitalizations, 111 patients were hypernatremic (3.46%). Sixty-five were admitted with hypernatremia, and 45 developed hypernatremia while hospitalized. Fifteen had recurrent episodes of hypernatremia. Forty-nine had associated hypokalemia and six had hypercalcemia. The etiology was multifactorial and varied with age. Correction of the hypernatremia within 4 days produced significant improvement in mental status. The overall mortality was 48.6%, and age did not favorably influence mortality.

Hypernatremia is a common disorder of elderly hospitalized patients, associated with high mortality and morbidity. Other electrolyte disorders that impair the kidney concentrating ability frequently are observed. The etiology is multiple, and febrile illness due to bacterial infections is the most common cause among the elderly. Prompt treatment of infections and increased water intake in this group of patients could prevent its development. Correction over a 72-hour period significantly improved recovery of mental functions. (*J Natl Med Assoc.* 1995;87:220-224.)

Key words • hypernatremia • elderly • aging • geriatrics

Hypernatremia (plasma sodium >150 mEq/L) is a common electrolyte disorder of elderly patients and has been reported to vary in incidence between 0.3% and 2.25% of hospital admissions. Hypernatremia is associated with a high mortality rate of approximately 40%[1-7] and almost definitely contributes to the morbidity and mortality of underlying diseases such as diabetic ketoacidosis, intracranial disorders, and acute illness in elderly subjects with a previous polyuric state.[8-10]

This article describes a study to determine if age influenced the incidence, clinical manifestations, morbidity, and mortality of hypernatremia on adult patients admitted to an acute care hospital over a 6-month period. In addition, the study sought to determine the velocity of correction of hypernatremia that produces the best clinical results.

SUBJECTS

Records of all adult patients who were admitted to the medical and surgical wards at Kingsbrook Jewish Medical Center, Brooklyn, New York, during a 6-month period with hypernatremia or having developed hypernatremia during their hospitalization were reviewed prospectively. Hypernatremia was defined as a serum sodium level >150 mEq/L. Demographic characteristics such as age, gender, primary and secondary diagnosis, length of stay, treatment, and outcome were

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TABLE 1. INCIDENCE OF HYPERNATREMIA CATEGORIZED BY AGE AND SEX IN 3208 PATIENTS

	No. Patients	No. Hypernatremics	Incidence (%)
Total	3208	111	3.46
Sex			
Males	1310	30	2.29
Females	1898	81	4.26
Age			
Group 1 (≥65 years)	1960	98	5.00
Group 2 (< years)	1248	13	1.04%

TABLE 2. STRATIFICATION OF HYPERNATREMIA AMONG 111 PATIENTS

Age	No. Males (%)	No. Females (%)	Total
Group 1 (≥65 years)	22 (22.4)	76 (77.6)	98
Group 2 (< 65 years)	9 (69.2)	4 (30.8)	13
Total	**31 (27.92)**	**80 (72.07)**	**111**

recorded. Place of origin, either from home or institutions, was noted.

Particular attention was given to the mental status of each patient during and after the correction of the hypernatremia. State of consciousness was classified as follows:

- alertness—a prompt response to all stimuli,
- obtundation—indifference to stimuli,
- stupor—arousable only by vigorous stimuli, and
- coma—absence of response to all stimuli.

Total body water (TBW) was calculated on the basis of age, gender and weight.[11] Water deficit was calculated using the formula: water deficit = TBW ([plasma sodium—140]/140). Water deficit replacement rates were based on records of intake and output as well as subsequent determinations of the serum sodium levels. Hypernatremia was considered to be corrected on the first day that serum sodium level fell below 150 mEq/L, and recurrence was diagnosed on the first day that the serum sodium level reached 150 mEq/L or higher.

Data were analyzed statistically using chi-square with and without continuity.

RESULTS

During the 6-month study period, 3208 patients were admitted to the medical and surgical wards. Of these, 111 (3.46%) were found to be hypernatremic at the time of admission or during their period of hospitalization. One patient was admitted twice with hypernatremia. The mean age of all patients was 66.4 years (range: 18 to 101). The mean age of the hypernatremic patients was 80 years (range: 35 to 99). For analysis, the 111 hypernatremic patients were divided into two groups: group 1—65 years and older, and group 2—< 65 years. More patients in group 1 than in group 2 were admitted from nursing homes, namely 92/98 (93.8%) compared with 6/13 (46%), respectively.

Age and gender characteristics of the total population and of the 111 hypernatremic patients are shown in Tables 1 and 2. Of the hypernatremic patients, 65 were identified at the time of admission, whereas 45 developed hypernatremia during the course of their hospitalization. The former patients exhibited a trend toward greater age than the latter (mean age: 82.8 ± 11.27 compared with 75.92 ± 14.96) and a higher likelihood of being admitted from nursing homes rather than from the home (92% compared with 80%). Similarly, their mortality rate tended to be lower (38.46% compared with 64.4%). These differences, however, were not statistically significant at the $P = .05$ level.

The mean peak TBW deficit among hypernatremic patients was 4.4 ± 1.68 L (range: 1.76 to 9.92 L). As a percentage of the estimated TBW, the mean deficit was $13.03 \pm 3.97\%$ (range: 7.5% to 25%). There was no significant difference between the deficits exhibited by group 1 patients compared with group 2 patients.

Recurrent episodes of hypernatremia were seen in 15 patients (13 in group 1 and 2 in group 2). The mean length of hospital stay of patients with recurrences was 56.93 ± 42.3 days compared with 31.57 ± 30.28 days (range: 1 to 220 days) for patients with single episodes ($P = .005$). The mortality rate of patients with recurrent hypernatremia was 66.6% compared with 45.83% for nonrecurrent hypernatremia, but this difference was not statistically significant.

The contributing cause of hypernatremia in patients categorized by age is listed in Table 3. The causes were multifactorial, and febrile illness occurring in patients with blunted response to thirst was most common and occurred almost exclusively in group 1 patients.

TABLE 3. CAUSES OF HYPERNATREMIA IN 111 PATIENTS BY AGE

Causes	No. in Group 1* (%)	No. in Group 2† (%)
Diuresis postacute renal failure	1 (1.0)	0 (0)
Diuresis postrelease of obstruction	3 (3.1)	0 (0)
Hypercalcemia		
Due to primary hyperparathyroidism	3 (3.1)	0 (0)
Malignancy	1 (1.0)	2 (15.4)
Bacterial infections (pneumonia, urinary tract infection, sepsis)	71 (72.0)	1 (7.7)
Intestinal obstruction	5 (5.1)	1 (7.7)
Terminal cancer unassociated with hypercalcemia	8 (8.2)	2 (15.4)
Uncontrolled diabetes mellitus	3 (3.1)	5 (38.5)
Gastroenteritis	3 (3.1)	0 (0)
Acquired immunodeficiency syndrome	0 (0)	2 (15.4)
Total	98 (100)	13 (100)

*≥65 years.
†< 65 years.

Uncontrolled diabetes mellitus was the most frequent cause in group 2 patients.

The combined occurrence of hypokalemia with high serum sodium levels either before or during correction of hypernatremia was seen in 49 patients (Table 4). This association was seen with equal frequency in both groups.

The correlation of mental status of hypernatremic patients with serum sodium level showed no significant difference in the level of consciousness of patients with serum sodium levels ≥160 mEq/L compared with patients with levels <160 mEq/L. This finding may be due to the small number of patients at each level of consciousness.

The rate of correction of hypernatremia and its relation to mental status was reviewed on a daily basis (Table 4). When correction of hypernatremia was achieved within 4 days, the mental status significantly improved ($P = .05$). Beyond 4 days, there was no significant improvement in cognitive function. The rate of correction of high serum sodium and its correlation with mortality also was tabulated on a daily basis (Table 5). No statistically significant correlation was observed, but it is noted that there was 100% mortality when the hypernatremia was not corrected within 10 days.

The overall mortality was 48.6%, and age did not favorably influence this factor. Group 1 patients had a 47% mortality rate while group 2 had a 61% mortality rate. Approximately one half of all patients died after correction of the hypernatremia. Patients with a water deficit >15% of TBW had a 63% mortality rate while those with a deficit <15% had a 43% mortality rate.

DISCUSSION

This demographic study showed a significant difference in frequency of hypernatremia associated with age. This susceptibility of elderly patients may be explained on the basis of physiological changes occurring in the body during the process of aging, namely, an increase in proportion of fat and a decrease in volume of TBW.[11-13] Other changes that predispose the elderly to this disorder include a decrease in perception of thirst accompanied by a diminished capacity to concentrate urine despite presence of higher levels of antidiuretic hormone in plasma.[12-14] However, Faull et al[15] have shown that normal elderly patients have a state similar to partial diabetic insipidus that may predispose them to dehydration and hypernatremia, and Yamamota et al[16] have produced evidence that impaired arginine vasopressin secretion associated with hypoangiotensinemia may be a contributory factor to development of hypernatremia in elderly patients. The increased occurrence in females also can be explained by physiological differences; females have lower value of TBW than men, and this volume further decreases with aging.[11] Hence, women are at a greater risk of becoming deficient of TBW than men. Other predisposing factors are the presence of comorbid conditions in the elderly causing immobility and frailty and increasing risk for dehydration.

The overall incidence of hypernatremia of 3.46% in

TABLE 4. IMPROVEMENT OF MENTAL STATUS IN RELATION TO SPEED OF CORRECTION*

Days of Correction	Group 1 (≥65 Years) Total No.	No. Improved (%)	No. Not Improved (%)	Group 2 (< 65 Years) Total No.	No. Improved (%)	No. Not Improved (%)
1	3	1 (33.3)	2 (66.6)	1	1 (100)	0 (0)
2	4	3 (75.0)	1 (25.0)	0	0 (0)	0 (0)
3	16	14 (87.5)	2 (12.5)	3	3 (100)	0 (0)
4	11	8 (72.7)	3 (27.3)	2	1 (50)	1 (50)
5	11	5 (45.4)	6 (54.6)	1	1 (100)	0 (0)
6	7	4 (57.1)	3 (42.9)	0	0 (0)	0 (0)
7	3	2 (66.6)	1 (33.4)	0	0 (0)	0 (0)
8	3	1 (33.3)	2 (66.6)	0	0 (0)	0 (0)
9	0	0 (0)	0 (0)	0	0 (0)	0 (0)
10	4	2 (50.0)	2 (50.0)	1	0 (0)	1 (100)
10+	3	0 (0)	3 (100)	0	0 (0)	0 (0)
Total	**65**	**40 (61.5)**	**25 (38.4)**	**8**	**6 (75.0)**	**2 (25)**

*Not included in this analysis are 21 patients who died before correction of the hypernatremia, 2 who were transferred to another institution before full correction of the hypernatremia, and 15 patients with recurrent hypernatremia, for a total of 111 patients.

this study is somewhat higher than that reported by others,[1-7] who observed rates varying between 0.3% and 2.25%. The higher rate in this study may reflect the demographic characteristics of our institution, which cares for an unusually large number of frail elderly individuals (Table 1).

The causes of hypernatremia varied significantly with age. In group 1 patients, febrile illness in individuals with decreased sensorium was the most common cause (72%). In contrast, group 2 patients exhibited hypernatremia most frequently as a result of dehydration due to uncontrolled diabetes mellitus. The causes in general were multifactorial, as shown in Table 3. These findings are in agreement with others.[1-7,10] It is noteworthy that the association of hypokalemia with hypernatremia has not been reported in prior studies. Its correction is important because it reverses the defect in the concentrating ability of the kidney[17] and thus improves water conservation.[18]

There was a statistically significant difference between the speed of correction of hypernatremia and improvement in mental status (Table 4). Correction of hypernatremia within 4 days was associated with a higher frequency of improvement in level of consciousness. Correction extended over more than 4 days was associated with a tendency toward permanent loss of cognitive function. Such delays in correction of hypernatremia have been noted by others[5,16] and may result from lack of awareness by the medical and nursing staff of the associated risk of permanent brain damage. While too long a delay appears to result in a poor outcome in recovery of mental status, it also was noted that too rapid a correction (within the first day) was associated with lack of improvement in mental status.[19]

The speed of correction of hypernatremia (Table 5) tended to correlate with mortality, although the correlation did not reach statistical significance. Lowest mortality was observed when normalization was accomplished within 3 to 4 days, and there was increased mortality associated with rapid correction (1 day) as well as slow correction (beyond 4 days).

These data are consistent with that of others[1,5] and indicate that the overall mortality associated with hypernatremia is high. In this study, the mortality rate was 48.6%. It is of interest that mortality was not favorably influenced by age: group 2 patients had a 46% mortality rate and group 2 patients had a 60% mortality rate. The reason for this difference may be attributed to the presence of more serious medical problems in the younger patients with this disorder (eg, acquired immunodeficiency syndrome and malignancy). Of further note is that higher mortality occurred among patients who developed hypernatremia during hospitalization than among those with hypernatremia on admission, and it was also higher among patients with recurrent hypernatremia. This difference was due to the presence of a greater degree of comorbidity when mortality was correlated

TABLE 5. MORTALITY IN RELATION TO SPEED OF CORRECTION BY AGE GROUPS*

Days of Correction	Group 1 (≥65 Years)		Group 2 (< 65 Years)	
	No. of Patients	No. of Deaths (%)	No. of Patients	No. of Deaths (%)
1	3	1 (33.3)	1	0 (0)
2	4	0 (0)	0	0 (0)
3	16	4 (25.0)	3	1 (33.3)
4	11	4 (36.3)	2	1 (50.0)
5	11	3 (27.3)	1	0 (0)
6	7	3 (42.8)	0	0 (0)
7	3	1 (33.3)	0	0 (0)
8	3	1 (33.3)	0	0 (0)
9	0	0 (0)	0	0 (0)
10	4	2 (50.0)	1	1 (100.0)
10+	3	3 (100.0)	0	0 (0)
Total	**65**	**22 (33.8)**	**8**	**3 (25.0)**

*Not included in this analysis are 21 patients who died before correction of the hypernatremia, 2 who were transferred to another institution before full correction of the hypernatremia, and 15 patients with recurrent hypernatremia, for a total of 111 patients.

with the degree of water deficit; there was a tendency for it to be higher when the water loss exceeded 15% of the estimated TBW, but the differences were not statistically significant ($P = 0.4$).

CONCLUSION

While hypernatremia frequently is associated with severe underlying medical illness, it is in essence an avoidable complication. There is a need for greater awareness among medical and nursing staff of the importance of maintaining hydration in susceptible patients.

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